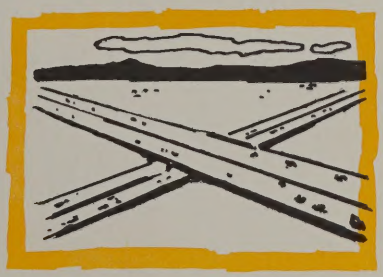
PILE FOUNDATION INVESTIGATION FOR ABUTMENTS AND RETAINING WALLS



bureau of electronic data processing

ENGINEERING DATA PROCESSING SERIES

OCTOBER - 1963

STATE OF NEW YORK

DEPARTMENT OF PUBLIC WORKS

PILE FOUNDATION INVESTIGATION

FOR

ABUTMENTS AND RETAINING WALLS

PROGRAM NUMBER 2704

Joseph P. Ronan
Administrative Deputy

J. Burch McMorran
Superintendent

NYSDOT
Library
50 Wolf Road, POD 34
Albany, New York 12232

OCTOBER 1963

STATE OF NEW YORK

DEPARTMENT OF PUBLIC WORKS

PILE FOUNDATION INVESTIGATION

FOR

ABUTMENTS AND RETAINING WALLS

PROGRAM NUMBER 270A

Joseph P. Kogan
Administrative Deputy

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Superintendent

OCTOBER 1963

NYSDOT
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50 Wolf Road, POD 34
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PILE FOUNDATION INVESTIGATION

FOR

ABUTMENTS AND RETAINING WALLS

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PILE FOUNDATION INVESTIGATION
FOR
ABUTMENTS AND RETAINING WALLS

PROGRAM NUMBER 2704.02

General

Given a general description of the problem, the program determines the maximum pile load, the vertical pile loads for each pile, the horizontal resistance of the pile groups, the externally applied horizontal load, the center of gravity of the pile group and the eccentricity or distance between the center of gravity of the pile group and the location of the resultant of all the loads. All important design information is listed.

SAMPLE OUTPUT

111.000

111.000

2.000	1.000	.000	.000	1.000	2.000	111.000
1.750	4.920	.000	.000	11.250	1.750	8.000
126.380	28.520	12.950	3.170	3.000	2.000	

111.000

111.000

MAX.VERTICAL PILE LOAD IN KIPS

PMAX	ROW 1	ROW 2	ROW 3	ROW 4	ROW 5
52.52	49.83	45.20	.00	.00	35.95

HOR.RESIST. PILE GROUP KIPS	EXT.HORIZ. FORCE KIPS	C.G. PILE GROUP FEET	ECC. FEET
80.28	82.10	4.91	.486

111.000

111.000

2.000	1.000	.000	.000	1.000	2.000	111.000
1.750	4.920	.000	.000	11.250	1.750	8.000
135.000	30.000	11.000	3.170	3.000	1.000	

111.000

111.000

MAX.VERTICAL PILE LOAD IN KIPS

PMAX	ROW 1	ROW 2	ROW 3	ROW 4	ROW 5
54.52	51.73	47.54	.00	.00	39.19

HOR.RESIST. PILE GROUP KIPS	EXT.HORIZ. FORCE KIPS	C.G. PILE GROUP FEET	ECC. FEET
82.33	69.74	4.91	.417

The moment of inertia method is used in the investigation. The investigation is limited to foundations having a maximum of five (5) rows of piles.

A Fortran listing of the program is attached to define engineering formulae, parameters, methods and sequence of operations.

```
      PROCEDURE NO.2704.02
      PILE FOUNDATION INVESTIGATION FOR
      ABUTMENTS AND RETAINING WALLS


      AT=NO.OF PILES IN ROW 1
      BT=NO.OF PILES IN ROW 2
      CT=NO.OF PILES IN ROW 3
      DT=NO.OF PILES IN ROW 4
      ET=NO.OF PILES IN ROW 5
      BAT=NO.OF ROWS OF BATTER PILES
      PROB=PROBLEM IDENTIFICATION NUMBER
      E1=DISTANCE FROM TOE TO C.L.ROW 1--FEET
      CX=DISTANCE FROM TOE TO C.L.ROW 2--FEET
      DX=DISTANCE FROM TOE TO C.L.ROW 3--FEET
      EX=DISTANCE FROM TOE TO C.L.ROW 4--FEET
      BX=DISTANCE FROM TOE TO C.L.ROW 5--FEET
      E2=DISTANCE FROM HEEL TO C.L.ROW 5---FEET
      POLL=ALLOWABLE HORIZONTAL LOAD PER PILE---KIPS
      ZJ=MOMENT ABOUT TOE---FOOT-KIPS
      ZV=TOTAL VERTICAL FORCE---KIPS
      HF1=TOTAL HORIZONTAL FORCE---KIPS
      SPIT=SPACING BETWEEN PILES IN ROW 1---FEET
      VERT=VERTICAL COMPONENT OF BATTER PILE
      CTR=NO.OF INPUT CARDS FOR ONE PARTICULAR
          PROBLEM AFTER CARD NO.3
    2 READ7,AT,BT,CT,DT,ET,BAT,PROB
```

```
      READ7,E1,CX,DX,EX,BX,E2,POLL
      READ7,ZJ,ZV,HF1,SPIT,VERT,CTR
 1001 PUNCH7,PROB
      PUNCH7,PROB
      PUNCH7,AT,B1,CT,DT,ET,BAT,PROB
      PUNCH7,E1,CX,DX,EX,BX,E2,POLL
      PUNCH7,ZJ,ZV,HF1,SPIT,VERT,CTR
      PUNCH7,PROB
      PUNCH7,PROB
      PUNCH 9000
 9000 FORMAT(//)
      GT=AT+BT+CT+DT+ET
      GTX=GT/AT
    4 CG=(AT*E1+BT*CX+CT*DX+DT*EX+ET*BX)/GT
    6 ECC=CG-ZJ/ZV
    5 IF(CX) 801,800,801
  800 D2=0.
      PL2=0.
  806 PL3=0.
      D3=0.
  807 PL4=0.
      D4=0.
      GO TO 805
  801 D2=CG-CX
      IF(DX) 803,806,803
  803 D3=CG-DX
      IF(EX) 888,807,888
```

```
 888 D4=CG-EX
 805 D5=CG-BX
     D1=CG-E1
     T1=D1*D1*AT
     T2=D2*D2*BT
     T3=D3*D3*CT
     T4=D4*D4*DT
     T5=D5*D5*ET
     T=T1+T2+T3+T4+T5
     SP=SPIT*AT
1003 PDL=ZV*SP/GT
     PIM=ZV*SP*ECC/T
     PL1=PDL+PIM*D1
     IF(CX) 811,810,811
 811 PL2=PDL+PIM*D2
     IF(DX) 812,810,812
 812 PL3=PDL+PIM*D3
     IF(EX) 813,810,813
 813 PL4=PDL+PIM*D4
 810 PL5=PDL+PIM*D5
     PLMAX=PL1*SQRT(1.+VERT*VERT)/VERT
     IF(PLMAX-PL5) 708,707,707
 708 PLMAX=PL5
 707 ZZA=1./VERT
     HF1=HF1*SP
     XYZ=POLL*GT+PL1*ZZA*AT
     IF(BAT-2.) 232,233,234
```

```
  233 XYZ=XYZ+PL2*ZZA*BT
      GO TO 232
  234 IF(BAT-4.) 235,236,236
  235 XYZ=XYZ+PL3*ZZA*CT
      GO TO 233
  236 XYZ=XYZ+PL4*ZZA*DT
      GO TO 235
  232 PUNCH 9
9FORMAT(47H                    MAX.VERTICAL PILE LOAD IN,5H KIPS)
      PUNCH 1
1FORMAT(47H  PMAX      ROW 1     ROW 2     ROW 3     ROW 4,5X,5HROW 5)
      PUNCH8,PLMAX,PL1,PL2,PL3,PL4,PL5
    8 FORMAT(F7.2,5F10.2)
      PUNCH 9000
      PUNCH 10
10FORMAT(37HHOR.RESIST. EXT.HORIZ.   C.G.    ECC.)
      PUNCH 11
11FORMAT(32HPILE GROUP    FORCE   PILE GROUP)
      PUNCH 12
12FORMAT(37H   KIPS        KIPS      FEET    FEET)
      PUNCH 13,XYZ,HF1,CG,ECC
13FORMAT(F8.2,F12.2,F9.2,F9.3)
      PUNCH 9000
    7 FORMAT(8F10.3)
      IF(CTR) 1000,2,1000
 1000 READ7,ZJ,ZV,HF1
      CTR=CTR-1.
```

```
      GO TO 1001
      END
```

INPUT FORM

MADE BY _____ DATE _____
CHECKED BY _____ DATE _____
BACK CHECKED _____ DATE _____
BRIDGE _____

N.Y.S.D.P.W.

PILE FOUNDATION INVESTIGATION
ABUTMENTS AND RETAINING WALLS
2704.02

SQUAD NO. _____
JOB NO. _____
SHEET NO. ____ OF ____ SHEETS

E.D.P. 35

PARITY STOP 0 FLOW PROGRAM
% STOP SWITCHES 1, 2, 3, 4 OFF

COL	1 10	11 20	21 30	31 40	41 50	51 60	61 70
CARD NO. 1	AT NO. PILES - ROW 1	BT NO. PILES - ROW 2	CT NO. PILES - ROW 3	DT NO. PILES - ROW 4	ET NO. PILES - ROW 5	BAT NO. ROWS OF BATTER PILES	PROB PROBLEM IDENTIFICATION NO.
CARD NO. 2	E1 TOE TO C.L. ROW 1 Feet	CX TOE TO C.L. ROW 2 Feet	DX TOE TO C.L. ROW 3 Feet	EX TOE TO C.L. ROW 4 Feet	BX TOE TO C.L ROW 5 Feet	E 2 HEEL TO ℄ ROW 5 Feet	POLL ALLOW. HORIZ. LOAD / PILE Kips
CARD NO. 3	ΣJ MOMENT ABOUT TOE PER FOOT Foot - Kips	ΣV TOTAL VERTICAL FORCE PER FOOT Kips	HFI TOTAL HORIZ FORCE PER FOOT Kips	SPIT SPACING BETWEEN PILES - ROW 1 Feet	VERT. VERT. 1	CTR NO. OF CARDS AFTER CARD NO. 3	
CARD NO. 4	ΣJ MOMENT ABOUT TOE PER FOOT Foot - Kips	ΣV TOTAL VERTICAL FORCE PER FOOT Kips	HFI TOTAL HORIZ FORCE PER FOOT Kips				
CARD NO. 5	ΣJ MOMENT ABOUT TOE PER FOOT Foot - Kips	ΣV TOTAL VERTICAL FORCE PER FOOT Kips	HFI TOTAL HORIZ FORCE PER FOOT Kips				
CARD NO. 6	ΣJ MOMENT ABOUT TOE PER FOOT Foot - Kips	ΣV TOTAL VERTICAL FORCE PER FOOT Kips	HFI TOTAL HORIZ FORCE PER FOOT Kips				
CARD NO. 7	ΣJ MOMENT ABOUT TOE PER FOOT Foot - Kips	ΣV TOTAL VERTICAL FORCE PER FOOT Kips	HFI TOTAL HORIZ FORCE PER FOOT Kips				

Cards 4,5,6 and 7 are for additional loading conditions. If moments and forces are reduced, for cases when overstresses are permitted, this reduction must be kept in mind when studying the output of this program.

INPUT IDENTIFICATION

Card No. 1

Symbol	Field	Explanation
AT	xxxxxx.xxx	No. Piles - Row 1
BT	xxxxxx.xxx	No. Piles - Row 2
CT	xxxxxx.xxx	No. Piles - Row 3
DT	xxxxxx.xxx	No. Piles - Row 4
ET	xxxxxx.xxx	No. Piles - Row 5
BAT	xxxxxx.xxx	No. of Rows of Batter Piles
PROB	xxxxxx.xxx	Problem Identification No.

Card No. 2

E1	xxxxxx.xxx	Toe to C.L. Row 1 (Feet)
CX	xxxxxx.xxx	Toe to C.L. Row 2 (Feet)
DX	xxxxxx.xxx	Toe to C.L. Row 3 (Feet)
EX	xxxxxx.xxx	Toe to C.L. Row 4 (Feet)
BX	xxxxxx.xxx	Toe to C.L. Row 5 (Feet)
E2	xxxxxx.xxx	Heel to C.L. Row 5 (Feet)
PŌLL	xxxxxx.xxx	Allow. Horiz. Load per Pile (Kips)

INPUT IDENTIFICATION

Card No. 3

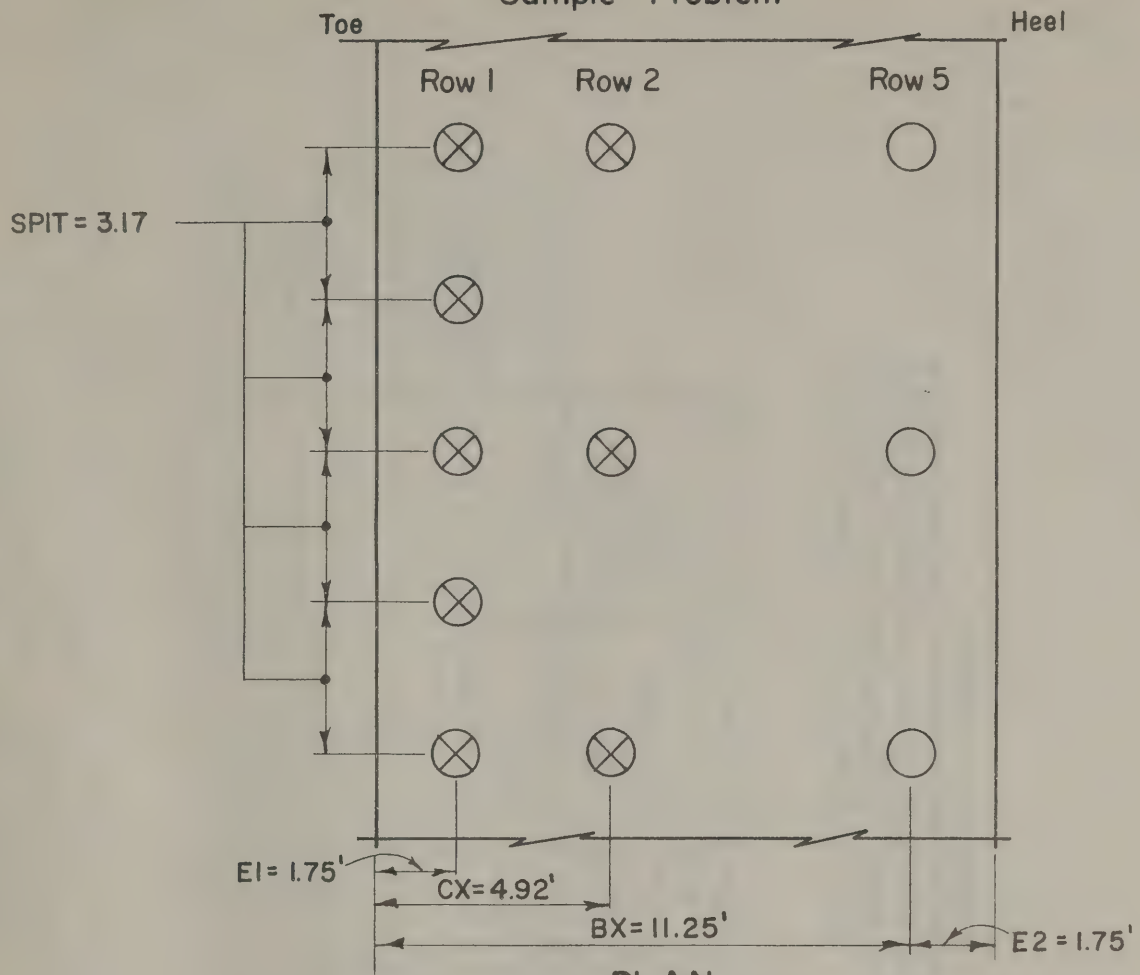
Symbol	Field	Explanation
ZJ	xxxxxx.xxx	Moment per foot about Toe (Ft-Kips)
ZV	xxxxxx.xxx	Total Vertical Force per Foot (Kips)
HF1	xxxxxx.xxx	Total Horizontal Force Per Foot (Kips)
SPIT	xxxxxx.xxx	Spacing Between Piles - Row 1 (Feet)
VERT	xxxxxx.xxx	Vertical Component of Batter Pile Relative to 1
CTR	xxxxxx.xxx	No. of Cards after Card No. 3.

Card No. 4

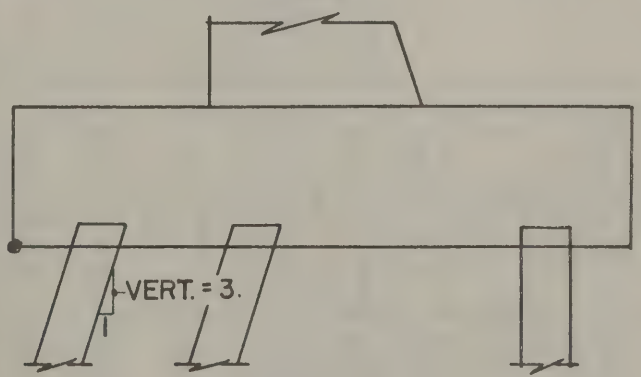
ZJ	xxxxxx.xxx	Moment per foot about toe (FT-Kips)
ZV	xxxxxx.xxx	Total Vertical Force per Foot (Kips)
HF1	xxxxxx.xxx	Total Horizontal Force per Foot (Kips)

Cards No. 5, 6, 7 etc. have the same input description as Card No. 4.

Sample Problem



PLAN



SECTION

⊗ Denotes Batter Pile
○ Denotes Vertical Pile

AT	= 2.	No. of Piles -	Row 1
BT	= 1.	"	Row 2
CT	= 0.	"	Row 3
DT	= 0.	"	Row 4
ET	= 1.	"	Row 5

SAMPLE PROBLEM INPUT

EDP 35

MADE BY T. P. DATE 10/1/63
CHECKED BY B. G. DATE 10/1/63
BACK CHECKED S.A.W. DATE 10/1/63
BRIDGE Castle Creek

N.Y.S.D.P.W.
PILE FOUNDATION INVESTIGATION
ABUTMENTS AND RETAINING WALLS
2704.02

SQUAD NO. 9
JOB NO. 111.
SHEET NO. 1 OF 1 SHEETS

PARITY STOP 0 FLOW PROGRAM
% STOP SWITCHES 1, 2, 3, 4 OFF

COL	1 10	11 20	21 30	31 40	41 50	51 60	61 70
CARD NO. 1	AT	BT	CT	DT	ET	BAT	PROB
	NO. PILES - ROW 1	NO. PILES - ROW 2	NO. PILES - ROW 3	NO. PILES - ROW 4	NO. PILES - ROW 5	NO. ROWS OF BATTER PILES	PROBLEM IDENTIFICATION NO.
	2.	1	0	0	1	2	111
CARD NO. 2	E1	CX	DX	EX	BX	E 2	POLL
	TOE TO C.L. ROW 1	TOE TO C.L. ROW 2	TOE TO C.L. ROW 3	TOE TO C.L. ROW 4	TOE TO C.L ROW 5	HEEL TO ℄ ROW 5	ALLOW. HORIZ. LOAD / PILE
	Feet	Feet	Feet	Feet	Feet	Feet	Kips
	1.75	4.92	0.	0.	11.25	1.75	8.
CARD NO. 3	ΣJ	ΣV	HFI	SPIT	VERT.	CTR	
	MOMENT ABOUT TOE PER FOOT	TOTAL VERTICAL FORCE PER FOOT	TOTAL HORIZ FORCE PER FOOT	SPACING BETWEEN PILES - ROW 1	VERT. / 1	NO. OF CARDS AFTER CARD NO. 3	
	Foot - Kips	Kips	Kips	Feet			
	126.38	28.52	12.95	3.17	3.	2.	
CARD NO. 4	ΣJ	ΣV	HFI				
	MOMENT ABOUT TOE PER FOOT	TOTAL VERTICAL FORCE PER FOOT	TOTAL HORIZ FORCE PER FOOT				
	Foot-Kips	Kips	Kips				
	135.	30.	11				
CARD NO. 5	ΣJ	ΣV	HFI				
	MOMENT ABOUT TOE PER FOOT	TOTAL VERTICAL FORCE PER FOOT	TOTAL HORIZ FORCE PER FOOT				
	Foot - Kips	Kips	Kips				
	150.	35.	15.				
CARD NO. 6	ΣJ	ΣV	HFI				
	MOMENT ABOUT TOE PER FOOT	TOTAL VERTICAL FORCE PER FOOT	TOTAL HORIZ FORCE PER FOOT				
	Foot-Kips	Kips	Kips				
CARD NO. 7	ΣJ	ΣV	HFI				
	MOMENT ABOUT TOE PER FOOT	TOTAL VERTICAL FORCE PER FOOT	TOTAL HORIZ FORCE PER FOOT				
	Foot-Kips	Kips	Kips				

Cards 4,5,6 and 7 are for additional loading conditions. If moments and forces are reduced, for cases when overstresses are permitted, this reduction must be kept in mind when studying the output of this program.

SAMPLE PROBLEM-OUTPUT

```
C      SAMPLE OUTPUT
C
C
C
    111.000
    111.000
      2.000      1.000      .000      .000      1.000      2.000    111.000
      1.750      4.920      .000      .000     11.250      1.750      8.000
    126.380     28.520    12.950     3.170      3.000      2.000
    111.000
    111.000
```

MAX.VERTICAL PILE LOAD IN KIPS

PMAX	ROW 1	ROW 2	ROW 3	ROW 4	ROW 5
52.52	49.83	45.20	.00	.00	35.95

HOR.RESIST. PILE GROUP KIPS	EXT.HORIZ. FORCE KIPS	C.G. PILE GROUP FEET	ECC. FEET
80.28	82.10	4.91	.486

```
    111.000
```

111.000

2.000	1.000	.000	.000	1.000	2.000	111.000
1.750	4.920	.000	.000	11.250	1.750	8.000
135.000	30.000	11.000	3.170	3.000	1.000	

111.000

111.000

MAX.VERTICAL PILE LOAD IN KIPS

PMAX	ROW 1	ROW 2	ROW 3	ROW 4	ROW 5
54.52	51.73	47.54	.00	.00	39.19

HOR.RESIST. PILE GROUP KIPS	EXT.HORIZ. FORCE KIPS	C.G. PILE GROUP FEET	ECC. FEET
82.33	69.74	4.91	.417

111.000

111.000

2.000	1.000	.000	.000	1.000	2.000	111.000
1.750	4.920	.000	.000	11.250	1.750	8.000
150.000	35.000	15.000	3.170	3.000	.000	

111.000

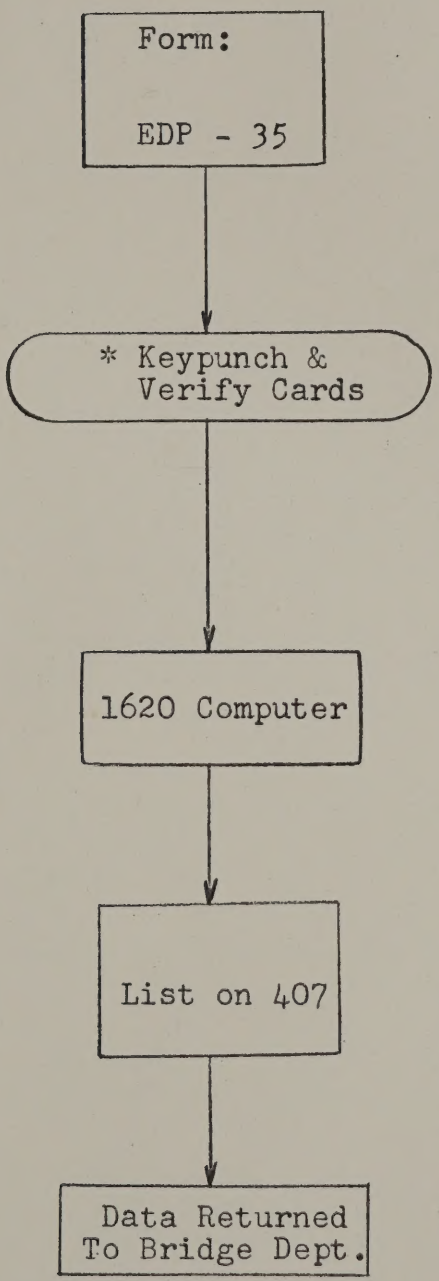
111.000

MAX.VERTICAL PILE LOAD IN KIPS

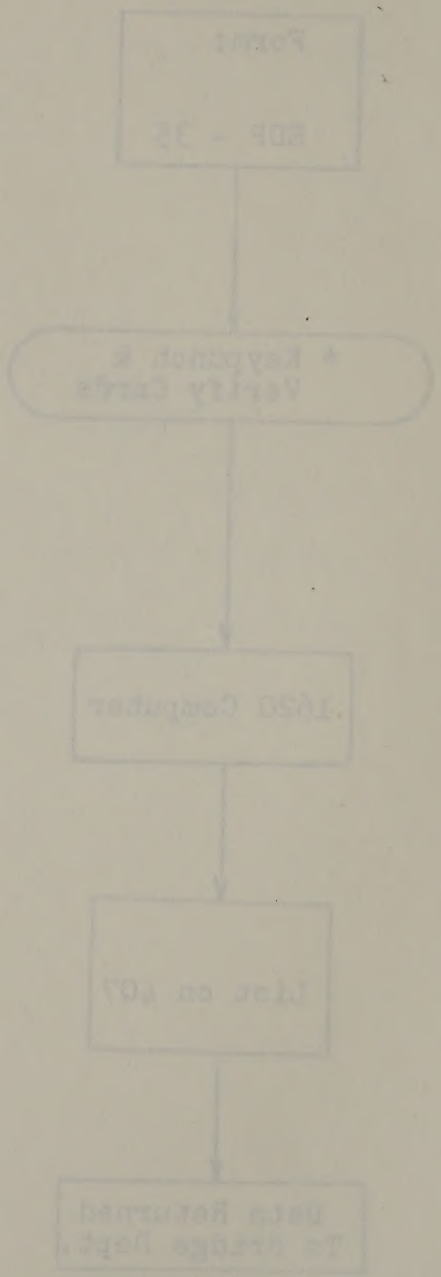
PMAX	ROW 1	ROW 2	ROW 3	ROW 4	ROW 5
66.25	62.85	55.46	.00	.00	40.71

HOR.RESIST. PILE GROUP KIPS	EXT.HORIZ. FORCE KIPS	C.G. PILE GROUP FEET	ECC. FEET
92.39	95.10	4.91	.631

SEQUENCE OF OPERATIONS



* Card Handling, key punch and computer instructions are available.



00300
LRI